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Diamond Shamrock

Thermal Power Company

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DEPT. OF LAND
& NATURAL RESOURCES
STATE OF HAWAII

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87 MAR 2 P3:41
DIV. OF WATER &
LAND DEVELOPMENT

Ralph A. Patterson, Jr.
Hawaii Project Manager

26 February 1987

Mr. William Paty
Chairman
Board of Land and
Natural Resources
Kalanimoku Bldg. Rm. 130
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Paty:

Recently, Thermal Power Company submitted a proposal to the California Energy Commission (CEC), in response to a solicitation for research projects connected with their Energy Technologies Advancement program. The proposal includes the drilling of test wells and the conduct of a geothermal gas injection research program in Puna.

The proposal has been under technical review by the CEC staff. In connection with a meeting with Thermal Power on Thursday of this week, CEC staff indicated that they have, or will shortly, contact Hawaii-based agencies to assist in this review.

A copy of the proposal submitted to the CEC is enclosed for your information and review. We will be happy to discuss the proposal in detail, and its relationship to the entire geothermal development in Puna, at your convenience.

Sincerely yours,

Ralph A. Patterson

encl
PATYCEC

MAR 16 1987

Mr. Ralph A. Patterson
Hawaii Project Manager
Thermal Power Co.
220 South King St., Suite 1750
Honolulu, Hawaii 96813

Dear Mr. Patterson:

This is to acknowledge receipt of your proposal submitted to the California Energy Commission (CEC) concerning the drilling of test wells and plans for geothermal gas injection research in Puna, Hawaii.

We appreciate your keeping us informed.

Very truly yours,

WILLIAM W. PATY
Chairperson of the Board

MT:DN:ko

GEOTHERMAL GAS INJECTION RESEARCH

Proposed Research Contract

Submitted to:

CALIFORNIA ENERGY COMMISSION
RFP 500-86-504

20 January 1987

THERMAL POWER COMPANY
3333 Mendocino Avenue
Santa Rosa, California 95401
Telephone: 707/576-7022

(FORM 1)

APPLICATION FORM

1. Brief Project Title: Geothermal Gas Injection Research

2. Organization Name: Thermal Power Company*

3333 Mendocino Avenue, Suite 120

Santa Rosa, California 95401

*A wholly owned subsidiary of Diamond Shamrock Corporation

4. Lead Person/Title/Phone No.: W. L. D'Olier

Vice President

707/576-7040

5. Project Location/City/County Puna Geothermal Field, Hawaii County, Hawaii

6. Funding Category:

Loan ____

Research Contract x

7. Proposed Length of Project

Tentative Project Starting Date: 1 July 1987

Tentative Project Ending Date: 31 December 1989

Proposed Repayment End Date for ETAP Loan: Not Applicable

8. Technology Type (e.g., photovoltaic, synthetic fuel, hydroelectric, etc.):

Geothermal-based electric power generation

9. Project Costs:

ETAP Funds:	$ 520,000
Match Amount:	$ 520,000
Total Project Cost:	$1,040,000

10. Amount(s), Source(s) and Form(s) of Matching Funds

Amounts	Sources	Forms (e.g., cash, in-kind services, etc.)
$470,000	Thermal Power Company	Cash from approved budgets.
$ 50,000	Thermal Power Company	In-kind services

11. Project Economics and Budget+

a. Identify any major source(s) of revenues or savings that are anticipated to result from the proposed project:

Source of Revenue(s)	Source of Saving(s)
None	Reduced chemical abatement costs
	Reduced trucking costs
	Reduced environmental costs and risk

b. Provide an estimated summary of the net cumulative cash flows for the project that would accrue by the end of the proposed term of the contract, as shown below:

Item	Estimated Cumulative Sum (Through Term of Contract)
Revenue(s) and Saving(s)	Possible Savings of $420,000 over 20 month injection
Operating and Other Project Expenses	$1,040,000
Net Cash Flow: Before Taxes and Financing Costs	None
Taxes and Financing Costs	None
Net Cash Flow: After Taxes and Financing Costs	None

Note: Attach a project budget+ and supporting cash flows that show how project match funds and ETAP funds will be used each year throughout the term of the contract and which identifies project revenue(s) and/or saving(s), project expenses, taxes and financing costs, and net cash flow(s).

For applicants that will be using ETAP funds for subcontractor services, specific budget information, as described in Section I (B), item 4 of the Appendix, must be included in the proposal.

Project Budget: Major Elements and Gross Costs*

3 Monitor Holes and 1 Injector Conversion	$ 670,000
Injection Hardware Package	95,000
Research Program	275,000
Total	$1,040,000

*Detailed in Worksheets enclosed, end of proposal.

Anticipated Funding and Expenditures by Year and Category

	1987	1988	1989	$000 Total
TPC - Match Funds				
Monitor Holes	325	10		335
Pruett PMS	40			40
Hardware		95		95
Staff Inputs (In Kind)	(25)	(13)	(12)	(50)
	390	118	12	520
CEC - ETAP Funds				
Monitor - Injector	325	10		335
Surface Gas Survey	13		12	25
Hydro Baseline	50			50
Samples/Chemical Analysis		30	30	60
Hydrological Consultant		30	20	50
Totals	388	70	62	520
Combined Total Match and ETAP Funds				$1,040
Project Savings		$231	$ 189	$ 420

11. c. Identify below the major item(s) and amounts for which ETAP funding will be used.

Item(s)	Amount of ETAP Funds
Boreholes	$335,000
Research Program	$135,000
Hydrologic Consultants	$ 50,000

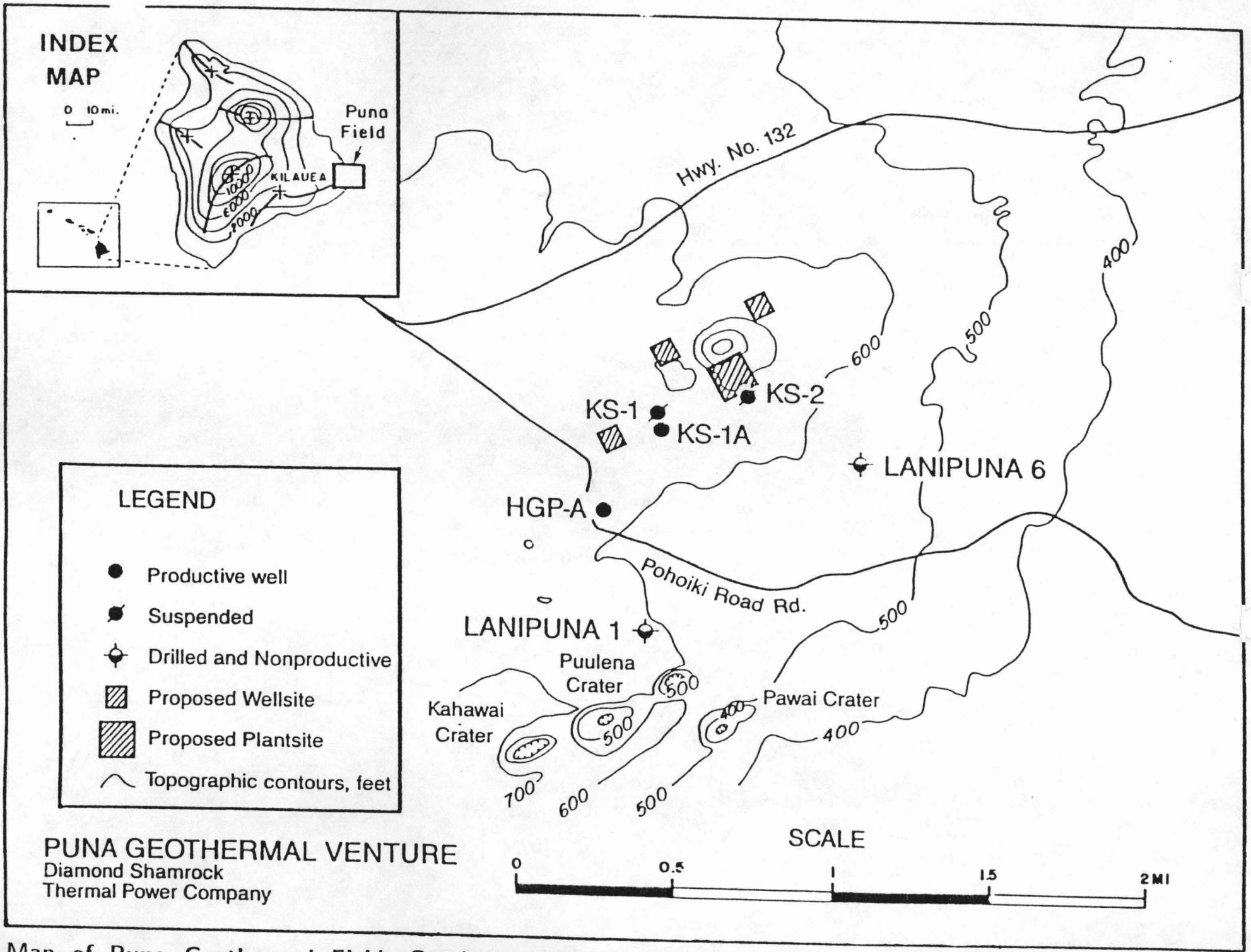
12. Concisely describe how the project will achieve at least one of the following three items: (a) increase the energy efficiency of the technology; (b) increase the cost-effectiveness of the technology; or (c) help to develop a new cost effective alternative source of energy.

(b) Geothermal gas injection, if workable within the site-specific hydrology surrounding a productive geothermal reservoir, would reduce or possibly eliminate the requirement and cost burdens of chemicals, surface abatement equipment and trucking support. It would allow a major reduction in surface effluent treatment and disposal. By avoiding chemicals, potential toxic wastes are avoided. The effluent mass would not be increased in the disposal process and O&M costs are expected to be reduced 20% or more per kilowatt hour generated.

13. Project Summary

The context of the proposed geothermal gas injection research is of special importance. The project would provide a very valuable and timely link between two separate and successful endeavors in the Puna Geothermal Field (see map on following page). Hawaii Geothermal Project (HGP), a State of Hawaii entity, has generated electricity since April 1982 from a 3 MW turbine generator unit immediate to the HGP-A well which is not only the field discovery well but the sole source of steam to date. The 3 MW unit has a utilization record in excess of 90% and the electricity is sold to the local utility company. Thermal Power Company (TPC), as Operator for Puna Geothermal Venture (PGV) (75% TPC, 25% Amfac Energy, Inc.) penetrated and flow tested the reservoir in three additional offset wells on its adjoining State of Hawaii geothermal lease. Because of positive results, Puna Geothermal Venture is now submitting applications to construct a 25 MW geothermal power system with the first 12.5 MW unit scheduled to go on-line in 1989 Fourth Quarter.

The HGP-A 3 MW unit disposes of its gas product, containing a 900 ppm H_2S gas concentration, by surface chemical abatement and surface discharge of the by-products at a cost burden of approximately $21,000 per month for chemicals, equipment, trucking, etc. TPC, finding 1200 ppm H_2S gas concentrations in its wells, proposes to evaluate and use gas disposal by injection into moderate depth groundwater bodies to avoid comparable costs and to reduce the



Map of Puna Geothermal Field, Geothermal Wells, Wellsites and Plantsite for PGV's 25 MW System

13. Project Summary (continued)

environmental impacts. By recent agreement between the successor in interest to HGP and TPC, geothermal steam from well KS-1A would be delivered to the 3 MW unit in a long term flow test of a second well in the Puna geothermal reservoir. TPC will then operate, commencing about June 1987, the integrated system of one flowing well, pipeline and generating unit. The HGP-A well would stand off-line for survey, scheduled repairs and backup steam supply. The site of the proposed research project would be within PGV's State geothermal lease and adjacent to the 3 MW unit. The three monitor holes would first allow a hydrologic baseline to be established in the objective aquifers which are indicated to contain groundwater contaminated by fluid leakage from the deeper underlying geothermal reservoir. Subsequent gas injection, using the KS-1A well gas stream exiting at the 3 MW unit condenser, would be accomplished and monitored over an extended 20-month interval.

Provide a brief description of the following:

(a) Overall project goals and specific performance criteria.

GOAL I: Demonstrate that an aquifer and its hydrology are suitable for geothermal gas injection as a disposal method.

Performances: Drill three monitor boreholes to 1700-2000' depth.
Balance cost considerations against information requirements.

Survey, measure, document the aquifer and hydrology parameters encountered in their natural (pre-injection) equilibrium state.

Issue Technical Report 1 on boreholes and hydrology.

GOAL II: Continuously inject non-condensible gas, containing H_2S in the approximate amounts of 65 pounds per hour, into one injector for a 20-month interval.

Performances: Convert one monitor borehole to an injector with casing modification, as required.

Monitor, measure, document the gas injectate impacts (front arrival and equilibrium conditions) in two offset monitor boreholes.

Issue Technical Report 2 on gas injection and impacts.

The Technical Reports prepared by TPC, with the assistance of its hydrologic consultant, will be the product of the work conducted under the proposed research contract. Full disclosure of objectives, procedures utilized, results, interpretations and conclusions obtained will be made in these Technical Reports. Publication will be made in a manner mutually determined by Thermal Power Company and the California Energy Commission, for early public availability.

(b) Specific methods(s) by which the project will accelerate commercialization of the technology.

This research should demonstrate that non-condensible gas disposal by injection into suitable aquifers would both lower costs and reduce environmental impact in the utilization of geothermal resources in the States of California and Hawaii, elsewhere worldwide. The elimination of chemicals, imported and applied on-site, would be a major step toward a closed loop cycling of geothermal effluent with its simpler recovery of heat.

(c) Reason(s) why State involvement is requested in the project.

The State of California has a policy and long record of assisting its indigenous geothermal industry to achieve more efficient utilizations. The proposed research contract, if successful, would provide a valuable guide and procedure to other California geothermal resource developers in evaluating a possible option for lower cost disposal of geothermal gases.

Successful non-condensible gas injection in suitable aquifers and hydrologic regimes, which are immediate to an exploitable geothermal reservoir, promises to be a reliable disposal process with lower environmental profile and reduced logistical-transport impacts. A confirmed demonstration of this advantage would be of importance to all geothermal developers in California and worldwide.

Both Hawaii County and State agencies are in fact obtaining substantial assistance from California state, county and other jurisdictions in preparing to regulate the nascent Hawaiian geothermal industry. The special quality of the additional support that State of California would provide by involvement in the proposed research project, which will address the critical need for improved geothermal gas disposal, should win further positive recognitions of the California Energy Commission leadership in energy technology by Hawaiians, by Pacific Rim countries with favorable geothermal resource potentials and by worldwide authorities in geothermal utilizations.

(d) Anticipated technical, economic and environmental benefits of the project.

Direct non-condensible gas injection would reduce the complexity and equipment requirements of the gas disposal function especially where the resource is burdened by significant H_2S content. Reduce or eliminate costs of chemicals, abatement equipment and trucking. Lower the environmental impact of the gas disposal function (see also number 12 above).

e) How the project will reduce consumption of nonrenewable energy resources.

Successful gas injection would reduce the petroleum inputs that are consumed in the chemical production and in the rail and truck transport required in the common surface abatement practices in geothermal industry.

f) Structure of the management organization for the project, including lines of authority and the lines of communication and interaction with the CEC.

See Attachment A

g) Applicability of the results from the proposed project and manner in which these results will be transferred to other projects.

The results of a successful geothermal gas injection and disposal achievement, as will be attempted and evaluated in this proposed research, should assist all geothermal development in the State of California by identifying and qualifying the injection disposal options that may be available. Transfer would be accomplished by Technical Reports 1 and 2 issued to public and by participation of an independent California based hydrologic consulting firm whose services will be available to all other California geothermal developers.

14. Work Statement and Schedule

Attach a detailed work statement and schedule based on the specific requirements of the project including at a minimum, phases, tasks, products, required permits and other project milestones. Show these activities on a timeline in positions relative to the project start, end, and other project activities. Show the approximate length of time required for each phase, task, etc. Discuss the work that will be required for all major phases, tasks, products, required permits and other project milestones. Identify the personnel responsible for conducting the work, including subcontractors and other consultants, if applicable.

Detailed Work Statement

1. Obtain approvals and permits for: a) three boreholes, sites and access; b) the entire gas injection procedure including one borehole conversion to injector, pipeline and pump requirements. These must be obtained from Board of Land and Natural Resources and Department of Health, State of Hawaii and from Planning Commission, County of Hawaii.

2. Utilize all current structural geologic information, hydrologic data of this portion of the East Rift Zone to select optimal borehole sites proximal to the HGP-A 3 MW turbine generator plant.

3. Drill and complete three boreholes, each in the range of 1700 to 2000 feet total depth, during August-October 1987.

4a. Evaluate aquifers in the fractured lava flow rock sequence penetrated by the three boreholes by rock and fluid sampling, borehole geophysical logging including pressure and temperature surveys. Record and document all hydrologic parameters of the baseline natural subsurface fluid regime penetrated.

4b. Complete and submit by 31 April 1988, Technical Report 1 to the California Energy Commission for a 30-day review before issue to the public.

5. Select the injector candidate (one of the three boreholes) and install additional casing to confine fluid injection to a selected depth interval. Install a gas transport pipeline and pump capacity between HGP plant and injector wellhead.

6a. Commence delivery and injection by 1 February 1988 of the non-condensible gas discharge from the HGP Plant into the injector and the aquifer. Control and record the mixtures of NCG and liquids injected, pressures and other key parameters. Sample and monitor all impacts in the two offset monitor boreholes. Continue gas injection and data collection for an expected 20-month interval.

6b. Complete and submit by 30 October 1989, Technical Report 2 to the CEC for a 30-day review before issue to the public domain.

Schedule, see following page

Discussion

The initial major phase of the proposed project would be the preparatory and permitting phase. This activity, predating research contract approval by CEC, would be accomplished at TPC's sole cost and risk. TPC must obtain permits from three Hawaiian agencies, subcontract with a Hawaii State licensed water well drilling firm and prepare drilling rig and material logistics to enable spudding the initial borehole about 45 days after a decision to proceed. Milestone 1 would be the date of receiving both a CEC-TPC executed research contract and all required Hawaii agency permits. D'Olier, Richard and Iovenitti will work the permit requirements. D'Olier and Bowden will prosecute the drilling subcontracting and logistical preparation.

SCHEDULE — GEOTHERMAL GAS INJECTION RESEARCH

100% COSTS AT APPROXIMATE TIME OF EXPENDITURE

1987

1ST PHASE PREP. + PERMIT

- PROPOSAL SUBMITTED
- RESEARCH CONTRACT ON
- MILESTONE 1
- START PERMIT PROCESS IN HAWAII
- PERMITS OBTAINED
- REFINE WORK ELEMENTS, COSTS, LOGISTICS
- SET HYDRO CONSULTANT
- SET DRILLING SUBCONTRACT

2ND PHASE DRILL + HYDRO BASE

- SURFACE GAS SURVEY $13,000
- BASELINE HYDROLOGY $50,000
- SHIP RIG
- DRILL 3 HOLES $650,000
- INSTALL PROETT AMS $40,000
- TPC STAFF $25,000
- MILESTONE 2A

1988

3RD PHASE PREP INJECT

- INJECTOR CONVERSION $20,000
- HARDWARE IN $95,000
- MILESTONE 3
- START GAS INJECTION
- HYDROLOGISTS $36,000
- TECH RPT 1 TO CEC

4TH PHASE INJECT + MONITOR

- TECH RPT 1 ISSUES
- SEE INJECTATE FRONT
- 11 MONTHS SAMP-CHEM AN $30,000
- TPC STAFF $13,000

1989

- SURFACE GAS SURVEY $12,000
- SEE INJECTATE MAX IMPACT
- DATA COLL STOP
- MILESTONE 4A
- 9 MONTHS SAMP-CHEM AN $20,000
- TPC STAFF $12,000
- HYDROLOGISTS $20,000
- TECH RPT 2 TO CEC
- TECH RPT 2 ISSUES
- RESEARCH CONTRACT CLOSED

The second phase would be the drilling and completion of three boreholes to 1700-2000 ft. TD and completion of borehole data collection and testing program allowing the hydrology to be evaluated and baselined. Milestone 2A would be the completion date of this field work. Borehole drilling and completion operations would proceed under D'Olier's direction and Bowden's on-site personal supervision. All wellbore evaluation procedures would be effected by Iovenitti and Goyal jointly. Iovenitti, Goyal and Weiss Associates would be the key parties involved in the hydrologic evaluation-baseline work. Iovenitti would direct the initial surface gas survey (subcontractor) during this phase. By 1 May 1988, TPC and Weiss will submit Technical Report 1, detailing the three boreholes and the hydrologic baseline, to CEC. Its intended release to public domain by 30 June 1988 would be Milestone 2B.

The third phase would include the conversion of one borehole to an injector configuration, installation of the injection hardware package (pipeline and pressure boosters, 3 MW unit cooling tower to injector wellhead). The initiation date of actual geothermal gas injection would close this phase as Milestone 3. Bowden and Goyal would accomplish the injector conversion. Bell and Goyal would jointly direct the construction and testing requirements for the hardware package.

The fourth phase would consist of the intended 20-month interval of geothermal gas injection and monitoring of its impact. The gas injectate should display a front arrival and subsequent equilibrium conditions in the two offset boreholes. Iovenitti and Goyal would direct the monitoring work. Iovenitti would complete a second surface gas survey, expectedly in mid 1989. Milestone 4A would be the conclusion of injection field data collection on 30 September 1989. Technical Report 2 preparation, CEC approval and release to public domain by 31 December 1989 would complete Milestone 4B coincident with termination of the research contract. D'Olier, Iovenitti, Goyal and Weiss would integrate all data to achieve quality data presentation, interpretation and conclusions in Technical Report 2.

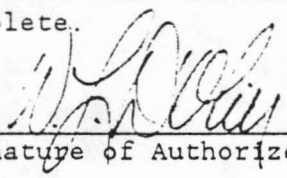
15. Financial Status of Applicant(s):

Provide a brief description of your company/agency's capability to provide the necessary non-ETAP funding over the life of the project. Attach copies of audited financial statements, which include business year end income statements, balance sheets, and capital statements and tax returns for the past two fiscal years for your company/agency.

Non-ETAP funding, which would be required to co-fund this proposed research contract, will be provided entirely by Diamond Shamrock Corporation in approved annual budget increments as is done for all other Thermal Power Company funding requirements. Specifically for its initial 12.5 MW development project in the Puna Geothermal Field, Thermal Power Company has an approved Authority for Commitment (AFC) in the amount of $28.3 million. Its 1987 Budget for this development project alone is $5,230,000. The non-ETAP funding will be provided from annual budgets under the AFC. Thermal Power Company, having signed a power sales contract with Hawaii Electric Company, is committed to putting initial wellfield and initial 12.5 MW unit on line by the Fourth Quarter 1989.

Copies of Diamond Shamrock Corporation Annual Reports are attached to this proposal and excerpts from tax returns, reporting Thermal Power Company income for the fiscal years 1984 and 1985, are submitted under separate cover subject to confidentiality protection.

I certify to the best of my knowledge and belief that I have read and understand the terms and conditions contained in this RFP and Appendix and that the information contained in this proposal is correct and complete.



Signature of Authorized Official

Date: 20 January 1987

W. L. D'Olier
Typed Name

Vice President
Geothermal Exploration
Title

Additional Materials Submitted with this Proposal:

1a. Attachment A to Form 1, addressing Item 13f.

1b. Three Work Sheets; Estimated 100% Cost Breakdowns for three main elements of proposed research contract.

2. Status of Compliance - Form 2

3. Contractor Status - Form 3

4. Resolution of Board of Directors - Form 4A

5. Annual Reports for 1984 and 1985 for Diamond Shamrock Corporation

6. Brochure (1985) "The Thermal Power Resource"

Separately delivered on 20 January 1987 to Contracts Office MS-18, California Energy Commission, 1516 Ninth Street, First Floor, Sacramento, California, excerpts from 1984 and 1985 U. S. Corporation Tax Returns by Diamond Shamrock Corporation, pertaining to Thermal Power Company.

APPLICATION ATTACHMENT A

CEC RFP 500-86-504
Form 1, Item 13(f)

The proposed research contract, if approved, would be executed and co-funded by Thermal Power Company (TPC) as sole contractor. TPC is a Diamond Shamrock operating unit containing 18 professional persons in a multidisciplined staff which exclusively works on geothermal energy enterprises. TPC headquarters in San Francisco contain the senior management, engineering, legal and human resource functions. The Santa Rosa office undertakes both geothermal resource and new business developments. The rapidly accelerating Hawaiian operations are worked in the Honolulu and Hilo offices.

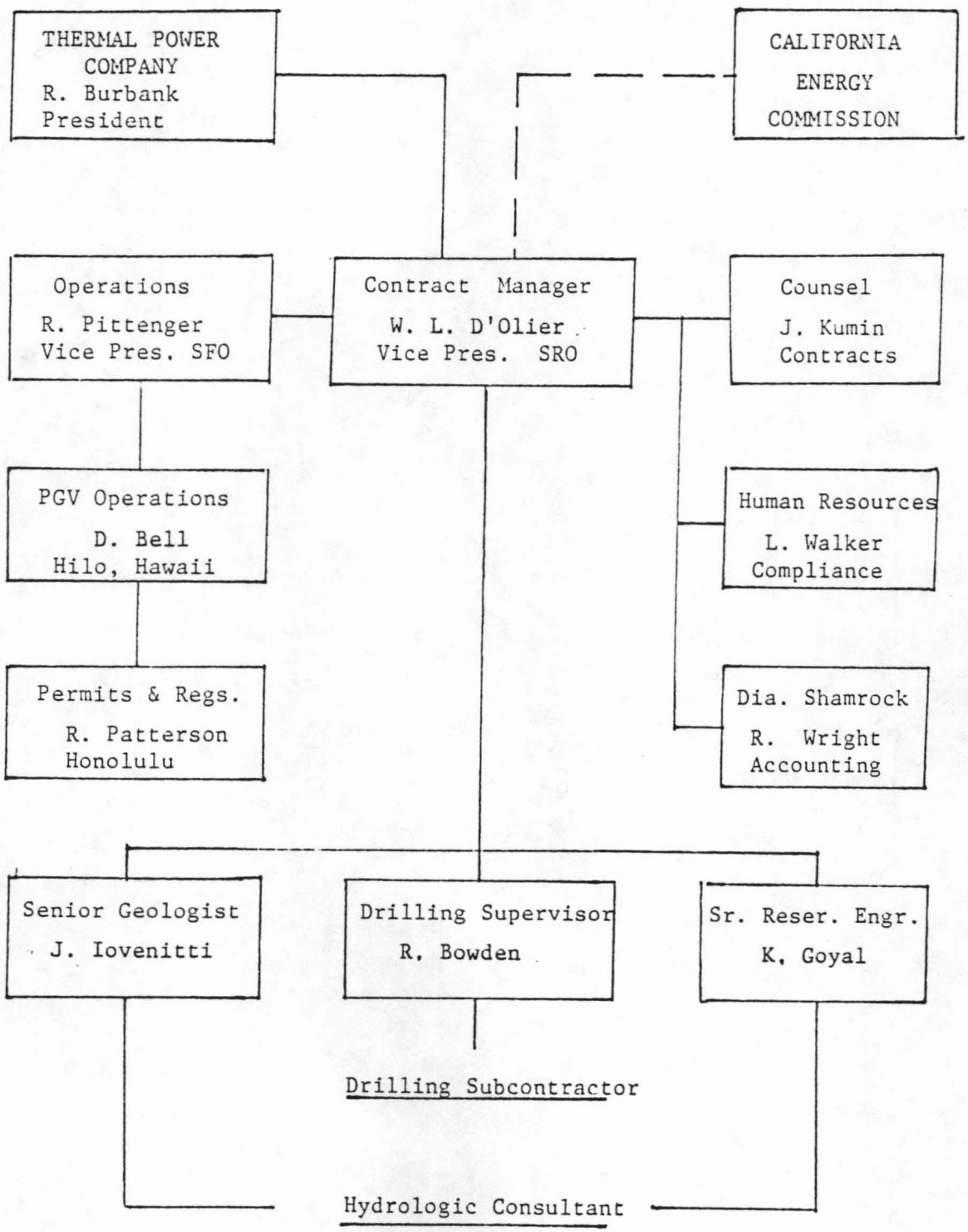
The geothermal industry experiences which TPC has obtained from its long participation in The Geysers geothermal field and five years of Puna field operations provide strong qualifications behind this proposal. Every element of the work detailed in Item 14 of Form 1 will be coordinated and accomplished by the five-person key employee team assigned to the proposed research contract. The following Table portrays the key persons within a management, authority and communication structure appropriate to an optimal accomplishment of the proposed contract objectives. Qualifications of the five key persons and of the important hydrologic consultant are also included.

A separate brochure entitled "The Thermal Power Resource" is enclosed with this proposal. It was published by Diamond Shamrock Corporation for distribution at the 1985 International Symposium on Geothermal Energy in Kona, Hawaii.

APPLICATION ATTACHMENT A

CEC RFP 500-86-504
Form 1, Item 13(f)

PROJECT MANAGEMENT, KEY PERSONS, AUTHORIZATION AND COMMUNICATION LINES



KEY PERSONS - Resumes Attached

Weiss Associates
2054 University Avenue
Berkeley, California 94704

Hydrologic Consultants proposed as subcontractor to Thermal Power Company (TPC) for geothermal gas injection research project. Qualifications and 1987 charge rates are attached.

Selection of Weiss Associates is based on the following:

1. Weiss has completed previous hydrologic studies for TPC in the Puna geothermal area of Hawaii County.

2. Proximity of TPC key staff in Santa Rosa and Weiss professionals and computer facilities in Berkeley will facilitate teamwork on important hydrologic issues.

3. Weiss has established a business record of competent professional consulting in groundwater issues, largely in California.

Following completion of proposed research contract, Weiss will be at liberty to apply its increased expertise for other California geothermal industry clients.

INTRODUCTION

Weiss Associates provides geologic, hydrogeologic and engineering services in water resources, water quality, environmental studies, engineering geology and geothermal energy. We work *with* our clients to develop and implement technically proficient and cost-effective solutions. Clients and regulatory agencies are consistently impressed with our high-quality work and innovative approaches to ground water projects. Our services include all project phases ranging from preliminary investigation and assessment to detailed hydrogeologic characterization, remedial action design and implementation, and regulatory compliance. We install monitoring and recovery wells, sample soil and ground water, perform hydraulic tests, model ground water flow and contaminant migration, excavate tanks, conduct site closures and recover hydrocarbons. Weiss Associates is effective in project design and management as well as report preparation and presentation.

Weiss Associates was established in 1980 by Richard B. Weiss, a Certified Engineering Geologist in California with more than 15 years experience in hydrogeology and geology. Our staff of hydrogeologists, engineers, geologists and technicians have many years of experience in ground water investigations and our Senior Associates are leading experts in their respective fields. Our diversity and experience ensure that innovative, comprehensive and effective procedures are used on all projects.

We employ the latest technology to ensure efficient work. Our office network of six microcomputers, modems, plotter/digitizer, laser and impact printers is used for hydrogeologic data storage and analysis, ground water modeling, access to mainframe computers and service networks, word processing and report preparation. Our field equipment includes an 8-channel data logger with extremely sensitive pressure transducers, portable submersible pumps, bladder pumps, oil/water interface probe, recording barometer, steam cleaners, air compressors and other essential tools for well development, hydraulic testing, and water and soil sampling.

Weiss Associates also provides soil and foundation engineering, soil science and surface water hydrology services through staff personnel as well as highly reputable senior associates. We coordinate and supervise support services such as drilling, trenching, chemical analysis, soil testing and other field surveys.

Weiss Associates offices are centrally located in the San Francisco Bay Area in downtown Berkeley, California. The extensive library and research facilities of the University of California, Water Resources Center Archives and Lawrence Berkeley Laboratory are within a few blocks. The Western Regional Division of the U.S. Geological Survey in Menlo Park and Stanford University in Palo Alto are within easy driving distance.

Some of the clients Weiss Associates has served over the past four years include:

United Technologies, Santa Clara
Intel Corporation, Sunnyvale
Oakland Scavenger Co., Oakland
Eureka Resource Associates, Berkeley
Burmah-Castrol, Inc., Hackensack, NJ
Del Davis Associates, San Rafael
Hercules Properties, Ltd., Hercules
EDAW, Inc., San Francisco
Nichols & Berman, San Francisco
Merrill & Seeley, Pleasanton
Geoexplor International, Oakland
Alan Kropp & Associates, Berkeley
U.S. Air Force, San Bernardino
Rockwell International, Newbury Park
Buro fur Hydrogeologie, Muhlefeld, Switzerland
Gennis & Associates, Engineers, Sacramento
Solano County Planning Department, Fairfield
Rich Diodati, General Contractor, South San Francisco
Masterson, Calhoun, Lundberg and Judge, Richmond
Bowie, Bort, Briegmann and Giacomini, San Francisco
Hoberg, Finger, Brown, Cox and Molligan, San Francisco
San Juan Ridge Taxpayers Association, Nevada City
Lawrence Livermore National Laboratory, Livermore
Southern California Federal Savings, Benicia
Precision Industries, Stockton
Thermal Power Company, San Francisco
Memorex Corporation, Santa Clara
Circo, Incorporated, Sunnyvale
Applied Materials, Santa Clara
VLSI Technologies, San Jose
Consulting Institute of America, Berkeley
U.S. Department of Justice, Washington, DC
TRW Microwave, Sunnyvale
Chevron USA, San Ramon
Cole/Mills Associates, Lafayette
Union Geothermal, Santa Rosa
ESL, Inc., Sunnyvale
Pacific Nursery Pots, Santa Clara
Lockheed Missiles & Space Co., Sunnyvale
California Environmental Technology, Richmond
TransWestern Environmental Services, Richmond
Nevada County Planning Department, Nevada City
Western Ecological Services Company, Novato
Sturgis, Ness, Brunsell & Sperry, Emeryville
Drs. Lerner, Burns & Associates, Larkspur
The Rreef Funds, Sunnyvale
Pacific Steel Casting, Berkeley
Fairchild Camera & Instrument Corp., Mt. View
Wells Fargo Bank, San Jose

1987 Schedule of Charges and Conditions

A new schedule of charges is issued at the beginning of each year. Unless other arrangements have been made via a proposal for a specific scope of work, charges for all work *including projects initiated in the prior year* will be based on the new schedule of charges. Our charges are divided into two categories: personnel and expenses.

PERSONNEL

Personnel charges are for any technical, clerical and/or administrative work performed on behalf of the client, including geologic and engineering functions as well as report preparation and project-related correspondence and administration. Direct charges are not made for secretarial service, office management, accounting and maintenance as these items are included in overhead. Personnel overhead costs include direct payroll costs, payroll taxes, vacation, holidays, sick leave, employee insurance and other benefits. Current personnel rates are as follows:

PROFESSIONAL SERVICES	HOURLY RATE
Senior or Principal Geologist, Hydrogeologist or Engineer	$ 80 to 95
Senior Project Geologist, Hydrogeologist or Engineer	65 to 80
Project Geologist, Hydrogeologist or Engineer	55 to 65
Senior Staff Geologist, Hydrogeologist or Engineer	50 to 60
Staff Geologist, Hydrogeologist or Engineer	45 to 55
Technician	35 to 45
Graphics/Draftsperson	39
Word Processing/Technical Editing	34
Clerical	28
Senior Associates	70 to 110

Charges for professional services are in increments of one quarter-hour. Minimum charge is four hours. Actual hourly rates depend on the individual assigned to a job, but will be in the range for their job category.

Depositions/legal testimony are charged portal-to-portal, $160/hr for the first two hours and $120/hr for each additional hour, with a two-hour minimum charge. In accordance with California Civil Procedure 2037.7, where applicable *the minimum fee must be paid prior to commencement of testimony.* Preparation for court cases is charged on a time-and-materials basis as outlined in this schedule.

The rates for personnel assigned to work outside the conterminous United States may be subject to premiums. Time spent in travel in the interest of the client will be charged at hourly rates except that no more than 8 hours of travel time will be charged in any day. When it is necessary for an employee to be away from the office overnight, actual costs of, or a negotiated rate for, living expenses will be charged.

THERMAL POWER COMPANY
Santa Rosa Office

WORKSHEET

Proposed Geothermal Gas Injection Research Project

Cost Estimate for Three Boreholes 1700-2000' Depths

Cost Per Well:

Road, Site Location	$ 6,000
Drilling Rig, 14 days @ $4000/day*	56,000
Drill Bits/Tools	4,000
Cuttings - Mud Logging	5,000
Mud and Chemicals	20,000
Casing (11-3/4" and 7")	25,000
Cement Materials	15,000
Geophysical Borehole Logs	25,000
Trucking and Hauling	3,000
Wellhead Equipment	10,000
Rental Equipment	1,000
Miscellaneous	5,000
Total Per Well	$175,000

Cost for 3 Wells	$525,000
Injector Conversion	20,000
Rig Mob/Demob (Mainland and Hilo)	125,000
GRAND TOTAL	$670,000

*Drilling subcontractor must be Hawaii licensed water well driller. Contemplate small truck mounted rotary rig from Hawaii or mainland; comparing costs, logistics and performance ratings.

KPG/ma
KPG133
1/19/87

THERMAL POWER COMPANY
Santa Rosa Office

WORKSHEET

Proposed Geothermal Gas Injection Research Project

Cost Estimate for Injection Hardware Package*

Gas Compressor	$ 57,000
Pump for Brine or Water Stream	6,500
Metering and Control Element	8,000
Valving	3,500
Inline Phase Mixer at Injector	4,500
Piping: Schedule 80	1,500
Construction	14,000
Total	$ 95,000

*Pipeline and pressure capacities required between HGP-A 3MW unit and proposed injector; based on ANSI for 600 psig maximum.

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THERMAL POWER COMPANY
Santa Rosa Office

WORKSHEET

Proposed Geothermal Gas Injection Project

Cost Estimate for Research Program

Pruett Pressure Monitor System	$ 40,000
Hydrologic Data Collection, Evaluation	50,000
Surface Gas Surveys (Minimum of Two)	25,000
Sampling, Chemical Analyses	60,000
Hydrologic Consultant (Weiss Associates)	50,000
Professional Staff TPC (in kind)	50,000
Total	$275,000

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(FORM 2)

STATEMENT OF COMPLIANCE

Thermal Power Company (hereinafter referred to as
(Company Name)

"prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 and California Administrative Code, Title II, Division 4, Chapter 5 in matters relating to the development, implementation and maintenance of a nondiscrimination program. Prospective contractor agrees not to unlawfully discriminate against any employee or applicants for employment because of race, religion, color, national origin, ancestry, physical handicap, medical condition, marital status, sex or age (over forty).

I Leslie B. Walker, Jr. hereby swear that I am
(Name of Official)

duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification executed on 16 January 1987 in the county
(Date)

of San Francisco is made under the penalty of perjury
(County)

under the laws of the State of California.

L. B. Walker Jr.
Signature

Manager-Administration
Title

STD. 19 (NEW 5-83)

State of California
CONTRACTOR STATUS FORM
CEC 83

(FORM 3)

California Energy Commission

Contractor's Name Thermal Power Company County Sonoma

Address 3333 Mendocino Avenue, Suite 120 Federal Employer ID# 94-1381438

Santa Rosa, California 95401

1. STATUS OF CONTRACTOR PROPOSING TO DO BUSINESS.

____ Individual ____ Limited Partnership ____ General Partnership x Corporation

A. Individual

If a sole proprietorship, state the true name of sole proprietor:

B. Partnership

If a partnership, list each partner, including limited partners, stating their true name and their interest in the partnership:

C. Corporation

If a corporation, place and date of incorporation: California

December 6, 1956

Date corporation was authorized to do business in California: December 6, 1956

President: Russell K. Burbank

Vice President: W. L. D'Olier (VP Exploration); R. T. Pittenger (VP Operations)

Secretary: Jane S. Kumin

Treasurer: Marian E. Ragland

Other Officers:

D. Small Business Preference

Are you claiming preference as a small business?

[ ] YES Date you filed for small business preference:

Your small business ID number:

[x] NO

(FORM 4A)

RESOLUTION OF BOARD OF DIRECTORS OR
AUTHORIZED REPRESENTATIVE*

Thermal Power Company

(Name of Applicant)

(1) RESOLVED, that the offices of this corporation named below, or any one of them, or any one of their, duly elected or appointed successors in office, be and they are hereby authorized and empowered in the name and on behalf of this corporation and under this corporate seal to execute and deliver to the State of California, California Energy Commission (hereinafter called "Commission") in the form required by Commission, the following documents: (a) application for a loan or research contract, the total thereof not to exceed in principal amount $1,040,000, maturing upon such date or dates and bearing interest at such rate or rates as may be prescribed by Commission, (b) applications for any renewals or extensions of all or any part of such loan or research contracts; (c) the promissory note or notes of this corporation evidencing such loan or loans or any renewals or extensions thereof; and (d) any other instruments or agreements of this corporation which may be required by Commission in connection with such loans, research contracts, renewals, and/or extensions; and that said officers in their discretion may accept any such loan or research contract in installments and give one or more notes of this corporation therefore, and may receive and endorse in the name of this corporation any checks or drafts representing such loan or research contract or any such installments;

(2) FURTHER RESOLVED, that the aforesaid officers or any one of them, or their duly elected or appointed successors in office, be and they are hereby authorized and empowered to do any acts, including but not limited to the mortgage, pledge, or hypothecation from time to time with Commission of any or all assets of this corporation to secure such loan or research contract, renewals and extensions, and to execute in the name and on behalf of this corporation and under this corporate seal or otherwise, any instruments or agreements deemed necessary or proper by Commission in respect of the collateral securing any indebtedness of this corporation;

(3) FURTHER RESOLVED, that any indebtedness heretofore contracted and any contracts or agreements heretofore made with Commission on behalf of this corporation in connection with said indebtedness or said contracts or agreements, are hereby ratified and confirmed:

(4) FURTHER RESOLVED, that the officers referred to in the foregoing resolutions are as follows:*

(Typewrite Name)	(Signature)
W. L. D'Olier	W. L. D'Olier

* The signature(s) of a legally authorized representative(s) of the Board of Directors can be substituted for the signatures of the board of Directors.

(1) The foregoing resolutions are subject to review of terms and conditions of research contract.

(5) FURTHER RESOLVED, that Commission is authorized to rely upon the aforesaid resolutions until receipt of written notice of any change.

CERTIFICATION+
(BY BOARD OF DIRECTORS)

I HEREBY CERTIFY that the foregoing is a true and correct copy of a resolution regularly presented to and adopted by the Board of Directors of _____ at a meeting duly called and held at _____ on the _____ day of _____, 19__, at which a quorum was present and voted, and that such resolution is duly recorded in the minute book of this corporation; that the officers named in said resolution have been duly elected or appointed to, and are the present incumbents of, the respective offices set after their respective names; and that the signatures set opposite their respective names are their true and genuine signatures.

(Seal)

_____
Secretary

CERTIFICATION+
(BY AUTHORIZED REPRESENTATIVE)

I HEREBY CERTIFY that the foregoing is a true and correct copy of a resolution signed by W. L. D'Olier, who is a legally authorized representative(s) of the Board of Directors of Thermal Power Co., and empowered to commit the Board to the foregoing resolutions, and that the signature(s) set opposite the authorized representative's name(s) their true and genuine signatures. (1)

(Seal)

_____
Secretary
Jane S. Kumin

(1) The foregoing certification is subject to review of terms and conditions of research contract.

+ The signature(s) of the legally authorized representative(s) of the Board of Directors can be substituted for the signatures of the Board of Directors. Use only the one certification signature block which is appropriate to the signatures.